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Major Article

Why do clinicians order inappropriate *Clostridium difficile* testing? An exploratory study

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Clostridium difficile
Decision making
Perspective

Background: The drivers behind *Clostridium difficile* testing are not well understood.
Methods: *C difficile* testing orders were reviewed. An algorithm that sequentially considered the presence of diarrhea, leukocytosis, fever, and laxative use was created. Tests deemed potentially inappropriate were discussed with the ordering team.
Results: Of 128 orders reviewed, 62% (n = 79) were appropriate. Patients whose testing was deemed inappropriate had longer lengths of stay. Diarrhea and laxative use were common and similarly distributed in those appropriately or inappropriately tested. The most commonly cited reason for ordering an inappropriate test was the reporting of diarrhea to the clinician by the patient or nursing that was not documented in the electronic health record. The next most common reason was clinician perception of risk. Demographics, laxative use, fever, leukocytosis, and diarrhea were similarly distributed between patients testing positive or negative by *C difficile* polymerase chain reaction.
Discussion: The discriminating value of diarrhea or laxative use in assessing for *C difficile* infection is poor. Multiple streams of information add to the complexities of decision making around *C difficile* testing. Inconsistent definitions of diarrhea likely contribute to this complexity. Clinician-perceived risk to the patient, partially driven by length of stay, may be a large driver of testing practices.
Conclusions: Without understanding the knowledge, attitudes, and values that underlie clinician behavior, interventions targeting ordering practices may not succeed.

BACKGROUND

Clostridium difficile infections (CDIs) caused approximately 29,000 deaths in the United States in 2011.[1] Although the incidence of CDIs has been rising, asymptomatic colonization with *C difficile* is also common, with a prevalence rate approaching 50% in persons living in long-term care facilities.[2] The increasing availability of highly sensitive molecular tests can therefore lead to the identification of symptom-free, colonized adults.[3] This heightens the importance of considering the clinical context in both ordering and interpreting *C difficile* testing.[4] Although this recognition has led to the development of several interventions targeting the stewardship of *C difficile* testing, few studies have assessed why clinicians order tests that may be incongruent with recommended guidelines. Our objective was to describe the clinical rationale driving stool *C difficile* testing.

METHODS

Setting

This work was conducted at a large, academic, urban, Midwestern hospital. During the investigation, our institution was using *C difficile* polymerase chain reaction (PCR) testing on stool samples, which detects the presence of the toxin B gene. The manufacturer reported that sensitivity of the test is 96.3%,

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whereas specificity is 92.4%.[5] Formed stool samples were rejected by the laboratory.

Definitions

Diarrhea was defined as documentation in the electronic health record of ≥3 unformed stools in the 24 hours preceding the testing order. Leukocytosis was defined as a white blood cell count ≥12,000 cell/mm^3 on the day of or the day before the order was placed. Temperature elevations ≥38°C in the preceding 48 hours were considered as fever. Laxative administration screened for the administration of docusate-senna, senna, polyethylene glycol, bisacodyl, sorbitol, magnesium citrate, and lactulose. If any of these agents were administered in the 24 hours before the testing order, the patient was considered to have received laxatives.

Testing appropriateness algorithm

An algorithm was created to facilitate the identification of appropriate versus inappropriate *C difficile* testing (Fig 1). Based on recommendations of the Infectious Diseases Society of America and the European Society for Clinical Microbiology and Infectious Diseases, leukocytosis and fever were included as prognosticators of severe infection.[2,6]

The algorithm considered the occurrence of diarrhea as the starting point in the decision tree. All *C difficile* testing orders on patients without diarrhea were considered potentially inappropriate and required a review of the clinical course. If the patient was noted to have ileus or otherwise unexplained leukocytosis or fever, the testing was considered appropriate. For patients with diarrhea, consideration was next given to the presence of leukocytosis and fever as a marker of possible severe infection.[2,6] If either were present, the testing was considered appropriate. In the absence of fever and leukocytosis, testing for *C difficile* in patients with diarrhea who had received laxatives in the preceding 24 hours was considered inappropriate. Conversely, testing in patients with diarrhea without the receipt of laxatives in the preceding 24 hours was considered appropriate. If the patient was identified to be a transplant recipient, testing was considered appropriate.

Population

C difficile testing orders placed on patients who were on medical, surgical, and progressive care units on the day of the order were

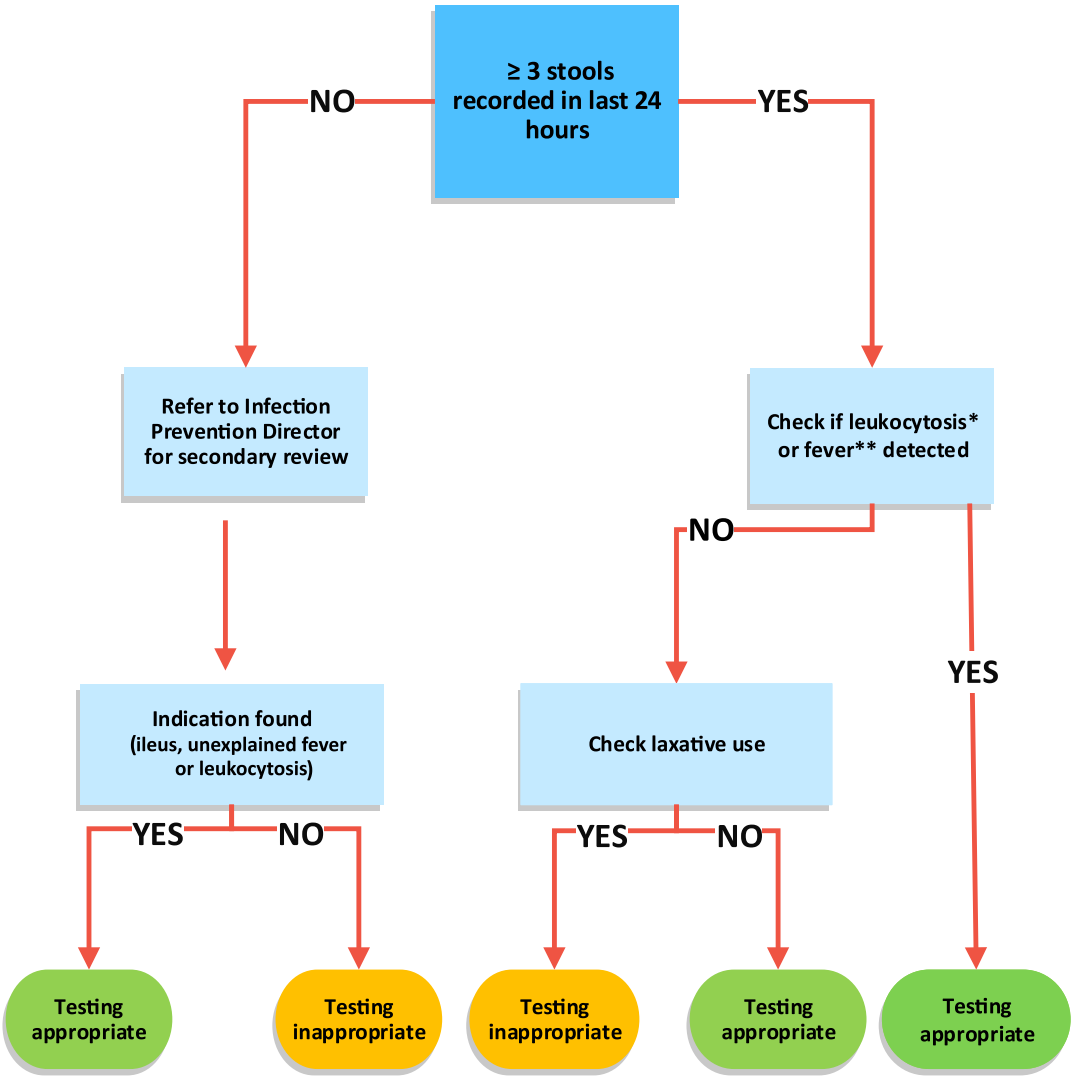

Fig 1. Algorithm to assess the appropriateness of the testing order. Data were obtained by electronic health record review. All orders placed on transplant recipients were considered appropriate. Discussion with the clinical team was indicated if the testing order appeared inappropriate. *Leukocytosis: white blood cell count ≥12,000 cells/mm^3. **Fever: oral temperature ≥38°C.

Table 1
Characteristics of patients on whom *Clostridium difficile* testing was ordered

	Appropriate *C difficile* testing N = 79 (62%)	Inappropriate *C difficile* testing N = 49 (38%)	*P* value
Mean age, y (SD)	59.6 (15.5)	60.2 (19.4)	>.05
Male sex, n (%)	35 (44.3)	21 (42.9)	>.05
Empiric *C difficile* treatment initiated, (%)	10 (12.7)	4 (8.2)	>.05
Diarrhea,* n (%)			.001
Present	29 (36.7)	11 (22.4)	
Absent	26 (33)	38 (77.5)	
Fever detected, n (%)	10 (12.7)	1 (2.0)	.05
Leukocytosis detected, n (%)	32 (40.5)	7 (14.3)	.002
Laxative administered before test order, n (%)	17 (21.5)	18 (36.7)	>.05
Median LOS on day of order (d)	2 (1–6)	5 (3–8)	.001
C difficile PCR positivity rate when sent, n (%)	9/57 (16.1)	7/38 (18.4)	>.05

LOS, length of stay: *PCR*, polymerase chain reaction.
*Excludes patients on whom data were missing or who were hospitalized <24 hours.

eligible for review. Orders placed on patients in the intensive care and obstetrics units were excluded.

Review process

Starting in January 2018, we conducted surveillance of *C difficile* orders for a period of 8 weeks. Our electronic health record (PowerChart; Cerner, North Kansas City, MO) enabled us to pull a list of all pending orders categorized by inpatient unit. During the study period, these orders were reviewed twice a day (morning and late afternoon) Monday through Friday by a member of the study team (W.S., A.B., A.K.). The first surveillance occurred between 11:30 AM and 1:30 PM and the second between 3:30 PM and 4:30 PM. The electronic health record was reviewed to determine the appropriateness of the testing. If testing was considered inappropriate, it was referred to the hospital infection prevention director (L.D.) for secondary review and discussion with the ordering clinical team on the same day. The conversation was semistructured and focused on understanding the reasons the team considered the testing appropriate.

Data collection

A data collection tool was created in RedCap, a secure web-based data collection and management system.[7] Demographic and clinical information was entered by the initial reviewers, and the outcomes and the discussion with the team were subsequently completed. Data on length of stay (LOS) and the results of testing (when sent) were collected after the patient was discharged.

Analysis

Results were summarized using descriptive statistics. The χ^2 tests were used for proportions except when cell counts were low when the Fisher exact test was used. For continuous variables, means were compared by use of t tests, and skewed variables such as LOS were compared using the Wilcoxon rank sum test.

RESULTS

Over the study period, 128 orders were reviewed. Most (62% [n = 79]) were consistent with appropriate testing. There were no differences in patient age and sex between tests that were appropriately ordered and those in which testing was inappropriate. Laxative use was noted in 21.5% (n = 17) of patients in whom testing was considered appropriate and in 37% (n = 18) of those in whom testing was considered inappropriate. The documentation of diarrhea in the previous 24 hours was noted in 36.7% (n = 29) of appropriately tested patients, whereas 22.4% (n = 11) of patients in whom testing was inappropriate also had the same frequency of stooling. The median LOS was longer in patients in whom the test was inappropriately ordered (Table 1).

Of the 49 testing orders that were deemed inappropriate, we were able to discuss the order with the clinical team in 32 (65%) instances. The most frequent reason (n = 15) was the reporting of diarrhea to the team either by the patient or the nurse that was not documented in the electronic health record. The next most common reason (n = 9) was the perception by the team that the patient was at high risk for developing CDI. Testing returned positive for 2 (22%) of the patients considered at high risk.

Overall, 26 % (n = 33) of tests ordered were never sent during the course of the hospitalization. Of these, 23 (69.6%) were tests considered appropriate based on our algorithm. Of the 95 orders that were ultimately sent and resulted, a total of 16 (16.8%) tests were positive. Demographics, laxative use, the presence of leukocytosis, fever, and diarrhea were similarly distributed between patients testing positive or negative by *C difficile* PCR testing. Significantly more patients who tested positive were initiated on empiric *C difficile* treatment than those who tested negative (31% vs 6%). The positive predictive value of the presence of diarrhea in our sample was 19% (7/37), whereas the negative predictive value of the absence of diarrhea was 90% (55/61) (Table 2).

DISCUSSION

Clinical practice guidelines recommend *C difficile* testing in the setting of new-onset, unexplained diarrhea defined as ≥3 unformed stools in a 24-hour period.[8] With the availability of highly sensitive molecular tests, restricting testing to symptomatic patients is essential to prevent the overdiagnosis and overtreatment of CDIs.[3] Various interventions aimed at increasing appropriate testing and treatment have been described with mixed results.[9–11] In this exploratory investigation, we aimed to describe the basis of *C difficile* ordering practices that may help us explain the successes or failures of prior interventions and assist in designing systems that better support adherence to guidelines.

Our results highlight the complexity of the decision making that surrounds *C difficile* testing in inpatients. Although our testing appropriateness algorithm was centered around the documented frequency of stooling, clinical teams receive data both from bedside nursing and the patients themselves that is inconsistently documented in the electronic health record. The reporting of diarrhea to the clinician either by the patient or the nurse was the most frequently cited reason for ordering testing that was inappropriate based on our review. This finding underscores the importance of using an objective definition of diarrhea such as the Bristol stool scale to educate both patients and the clinical team.[12] If clinicians, patients,

Table 2
Characteristics of patients based on testing results

	Clostridium difficile PCR positive (N = 16)	*C difficile* PCR negative (N = 79)	*P* value
Mean age, y (SD)	58.7 (17.8)	61.3 (16.9)	>.05
Male sex, n (%)	7 (43.8)	31 (39.2)	>.05
Empiric *C difficile* treatment initiated, n (%)	5 (31.2)	5 (6.3)	.01
Diarrhea,* n (%)			>.05
Present	7 (44)	30 (37.8)	
Absent	6 (37.5)	55 (69.6)	
Fever detected, n (%)	2 (12.5)	8 (10.1)	>.05
Leukocytosis detected, n (%)	5 (31.3)	23 (29.1)	>.05
Laxative administered before test order, n (%)	4 (25)	20 (25.3)	>.05
Median duration of hospitalization at time of order (d)	3 (1–5)	3 (1–10)	>.05
Median LOS (d)	9.5 (7.5–13)	11 (5–17)	>.05
Consistent with appropriate testing, n (%)	9 (56)	48 (61)	>.05
Inappropriate testing, n (%)	7 (44)	31 (39)	>.05

LOS, length of stay; *PCR*, polymerase chain reaction.
*Excludes patients on whom data were missing or who were hospitalized <24 hours.

and nursing staff rely on inconsistent definitions of diarrhea, the risk of miscommunication and overtesting is likely to increase. A previous investigation in a pediatric population found that an educational intervention coupled with an electronic reminder at the time of order entry aimed to decrease inappropriate testing was most successful in the outpatient population and least successful in inpatients.[10] The complex flows of information we found may at least partially explain the differing success in the inpatient and outpatient settings.

Adding to this complexity is the apparent nonspecificity of diarrhea in inpatients. In our sample, the positive predictive value of the occurrence of ≥3 stools in patients who ultimately tested positive by *C difficile* PCR was low at 19%. Efforts at curtailing testing in patients with diarrhea may be less successful than efforts and education focused on preventing testing in patients who do not have diarrhea. Laxative use in our sample yielded similar insights with the frequency of laxative use comparable in those ultimately testing positive or negative for *C difficile* by PCR testing. With the overall high prevalence of laxative use in the inpatient population, its value as a clinically meaningful discriminant to clinicians may be lost. This may explain why previous studies have found that clinicians continue to order *C difficile* testing even when they are aware of laxative use and overwhelmingly dismiss alerts regarding laxative use in patients at the point of order entry.[9,13] This may also point to the need for developing more stringent criteria for laxative use in the inpatient setting.

The teams often invoked their perception of risk as a reason for inappropriate testing. This finding was unexpected because we had excluded transplant and intensive care unit patients. Previous clinical decision support algorithms have found that clinicians continue to override recommendations, and it is possible that this is fueled by this perception.[9] Buckel et al[11] noted that an educational and feedback intervention was able to decrease testing but unable to decrease treatment in patients who were likely asymptomatically colonized. Ultimately, the risk from testing and overtreatment may be underestimated or undervalued by clinicians when compared with the risk of untreated CDI. Based on our findings of more inappropriate testing being sent in patients with a longer LOS, it is possible that this perception of risk parallels the patient's LOS; however, we are uncertain what other factors may inform this clinical gestalt. Concurrently, we found that empiric *C difficile* treatment was initiated before testing results in significantly more patients who ultimately tested positive than in those who tested negative. This gestalt therefore may have a clinical basis, and its accuracy deserves assessment. There is a need to understand and address risk perception because clinician behaviors are impacted both by knowledge and attitudes. Presenting data on risks, benefits, and harms in guidelines and in real time may help clinicians recalibrate the risk assessment for CDIs.[14,15]

Our work has some limitations. Importantly, this is a small, single-center investigation. We did not investigate testing patterns overnight or on weekends and did not delve into clinician characteristics that impact testing habits. We do not have information on nursing perspectives, without which our understanding of this issue is incomplete. Tests ordered and sent rapidly may not have been captured in our daily surveillance. Similarly, we lack information on tests that were ordered but ultimately not sent. Because PCR-based testing detects both CDI and asymptomatic carriers, our interpretations are restricted to test positivity rather than true disease.

CONCLUSIONS

These findings should be considered exploratory and deserve further study in different settings and with different testing. Without understanding the knowledge, attitudes, and values underlying clinician behavior, interventions targeting ordering practices may not be successful. It is our hope that our findings offer some actionable insights in the journey to *C difficile* testing stewardship.

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